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Reducing the Fish in Fish Feed: Sciences rush to Develop Alternative Ingredients

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It takes guts to be a carnivore

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Three Paradigms

- Ecological - Dominate
- Physiological
- Nutritional/Metabolic

…Salmon remain carnivores, and raising them in captivity inevitably shrinks the world's supply of edible fish…"

Seth Zuckerman
Bellingham Weekly
Sept 29 - Oct 5, 2005

"…It takes about three pounds of anchovies, mackerel and the like to raise a single pound of farmed salmon."

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Time Magazine

July 2011 by Brain Walsh

"Less than 20% of the barramundi's feed comes from fish meal and fish oil — a better percentage than for many farmed salmon, which can ***require*** *as much as 50% of their feed from fish meal."*

"Especially troubling, many of the most popular farmed species are carnivores, meaning they ***need to be fed*** *at least partly* ***with other fish****. By one count, about 2 lb. of wild fish ground up to make fish meal is* ***needed*** *on average to produce 1 lb. of farmed fish, which leaves the ocean at a net loss."*

"When producers began raising fish intensively, they picked species that people like to eat: salmon and sea bass. But those species are ***high on the food chain****, and raising them on a farm is a bit* ***like trying to domesticate tigers****"*

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Two Issues X three Paradigms

The ecological paradigm:

- Carnivores require fish meal and oil which logically means:
  - Industries growing them will be limited to the finite supply of industrial fish.
  - Herbivores are a better choice because they are at a lower tropic level.

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But...

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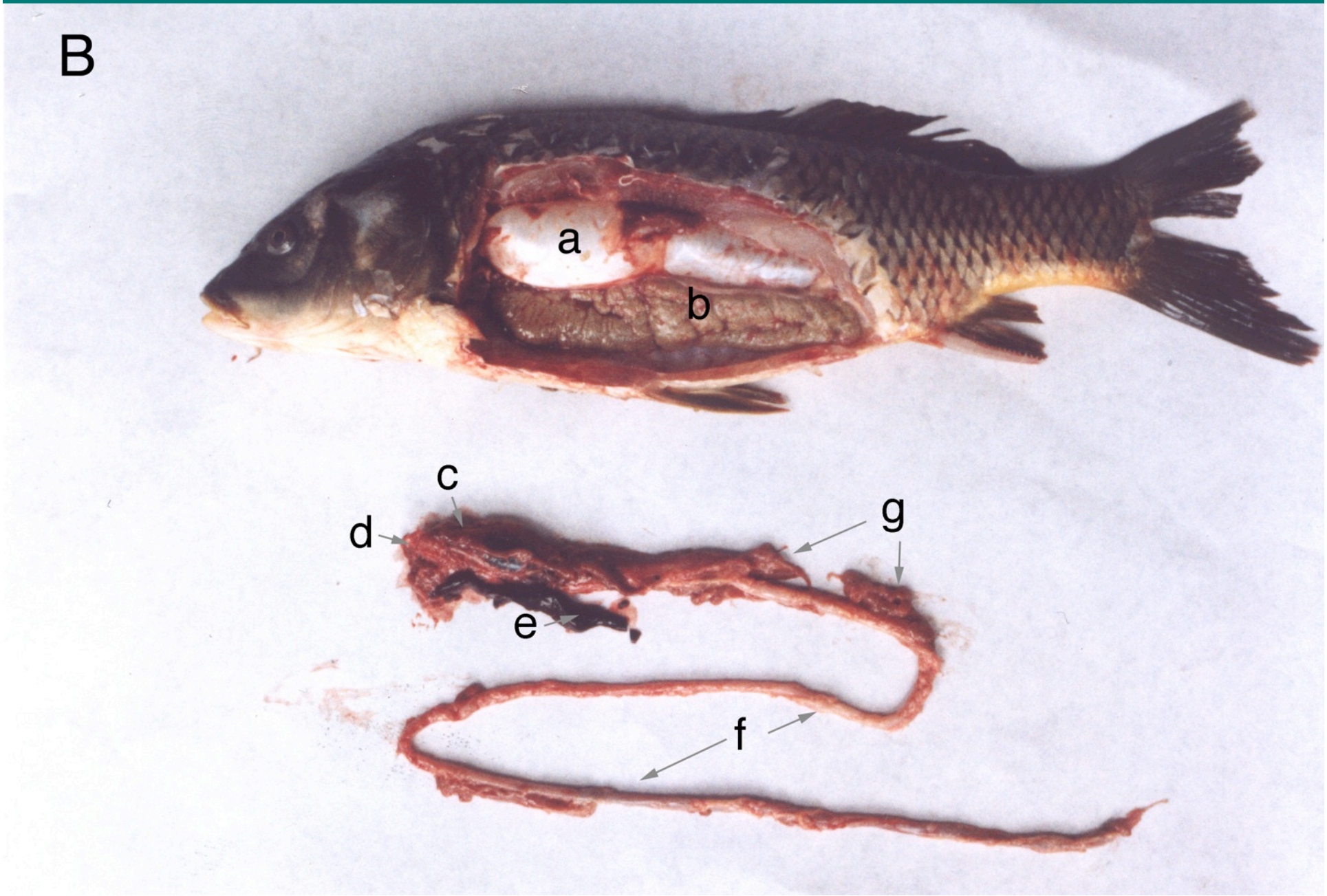
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Lingcod

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Physiology Paradigm

- Mono-gastric (aka Carnivore) fish **need protein and fat** with a minimum of carbohydrates.
  - Hard to catch
  - High nutritional value of food
- Agastric (aka Herbivore) fish would do better with **protein and fat but can tolerate high levels of carbohydrates**.
  - Easy to eat
  - Low nutritional value of food

→It's about the Carbs!

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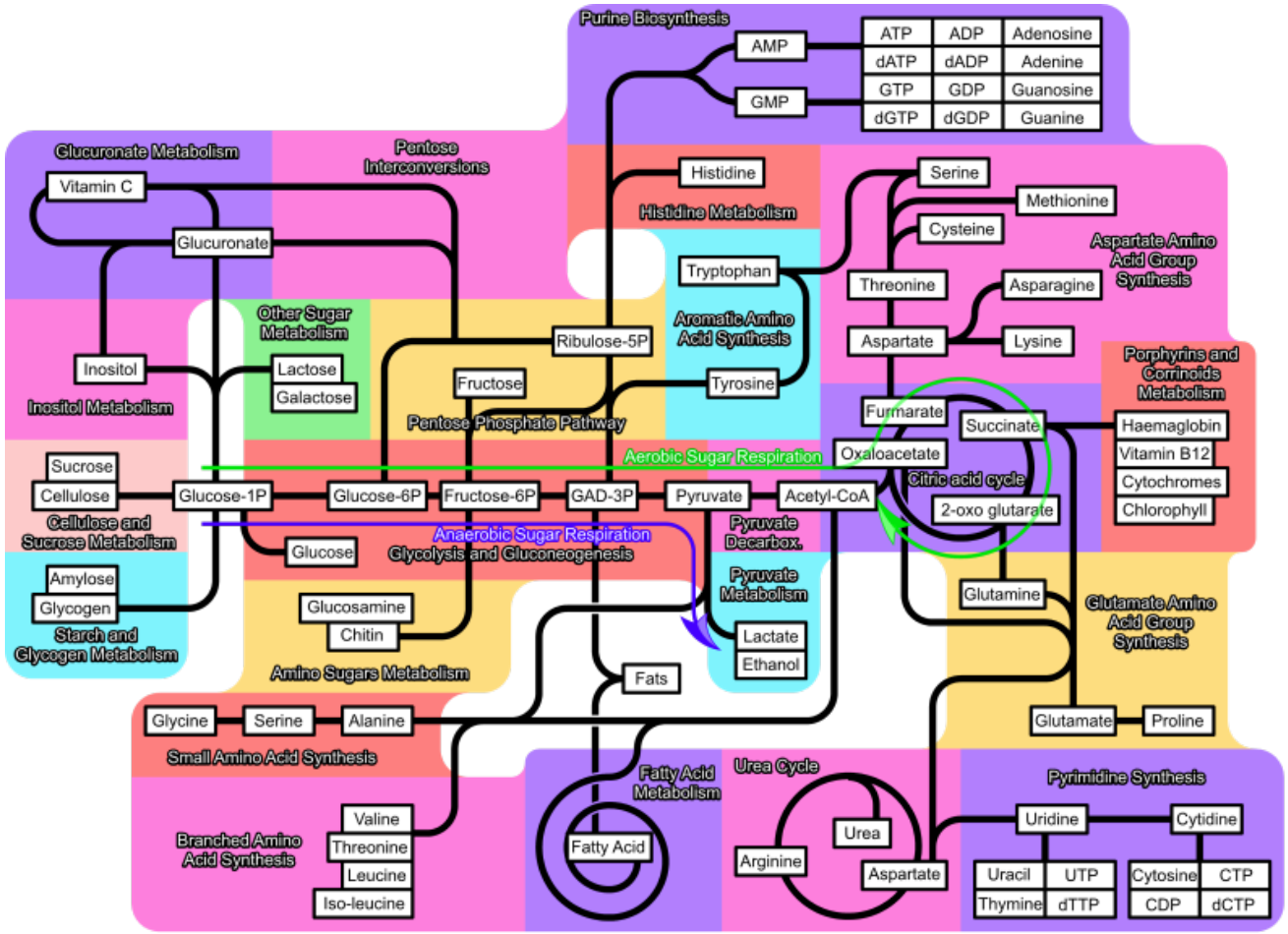
Nutritional/ Metabolic Paradigm

All fish, carnivore, herbivore or omnivore, require about 40 nutrients in the correct ratios and need to avoid anti-nutrients.



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Evidence please!

What happens if you feed carnivores diets with no animal meals?

- Salmon – Burr et al. 2012
- Shrimp - Sookying 2010, Olmos et al 2011
- Trout - Gaylord et al 2007
- Red Sea Bream - Takagi et al 2000
- Grouper - Shapawi et al 2007
- White Sea Bass - Trushenski et al in press
- Cobia – Watson et al 2012

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For the essential micronutrients it boils down to needing a few molecules

Long Chain N-3 Fatty acids

—EPA

—DHA

Amino acids

—Taurine

—Maybe one other?

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Freedom from fishmeal?

- So why is FM and FO still being used?
- What else is out there?

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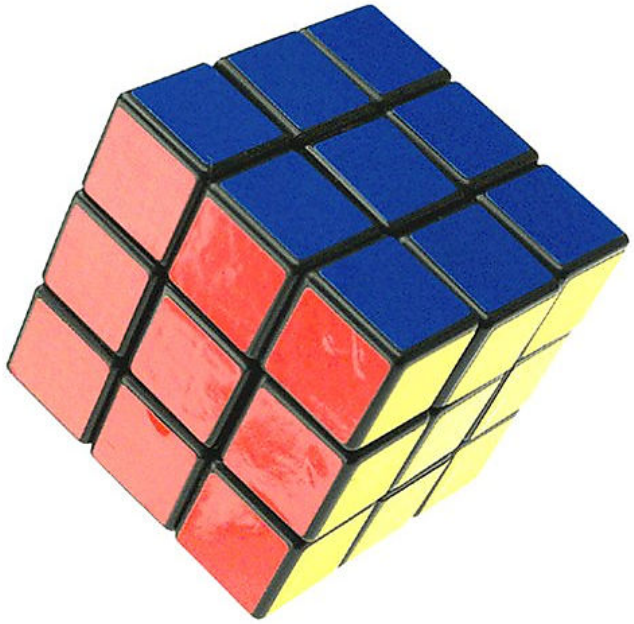
Fishmeal is the gold standard



Like buying a puzzle already put together

- Tastes good
- Correct Amino Acid Balance
- Correct Fatty Acids
- Easy to supplement vitamins
- No anti-nutrients
- Comes from well managed fisheries

However Fish meal and fish oil are fully-utilized, finite resources

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Other feedstuffs need some work

With Research and development effort:

- Taste can be improved or masked
- Amino acids can be balanced
- Fatty acids can be added
- Anti-nutrients can be removed
- Fish that like other feedstuffs can be selected for.

The puzzle can be solved with research ***But it takes $$$***

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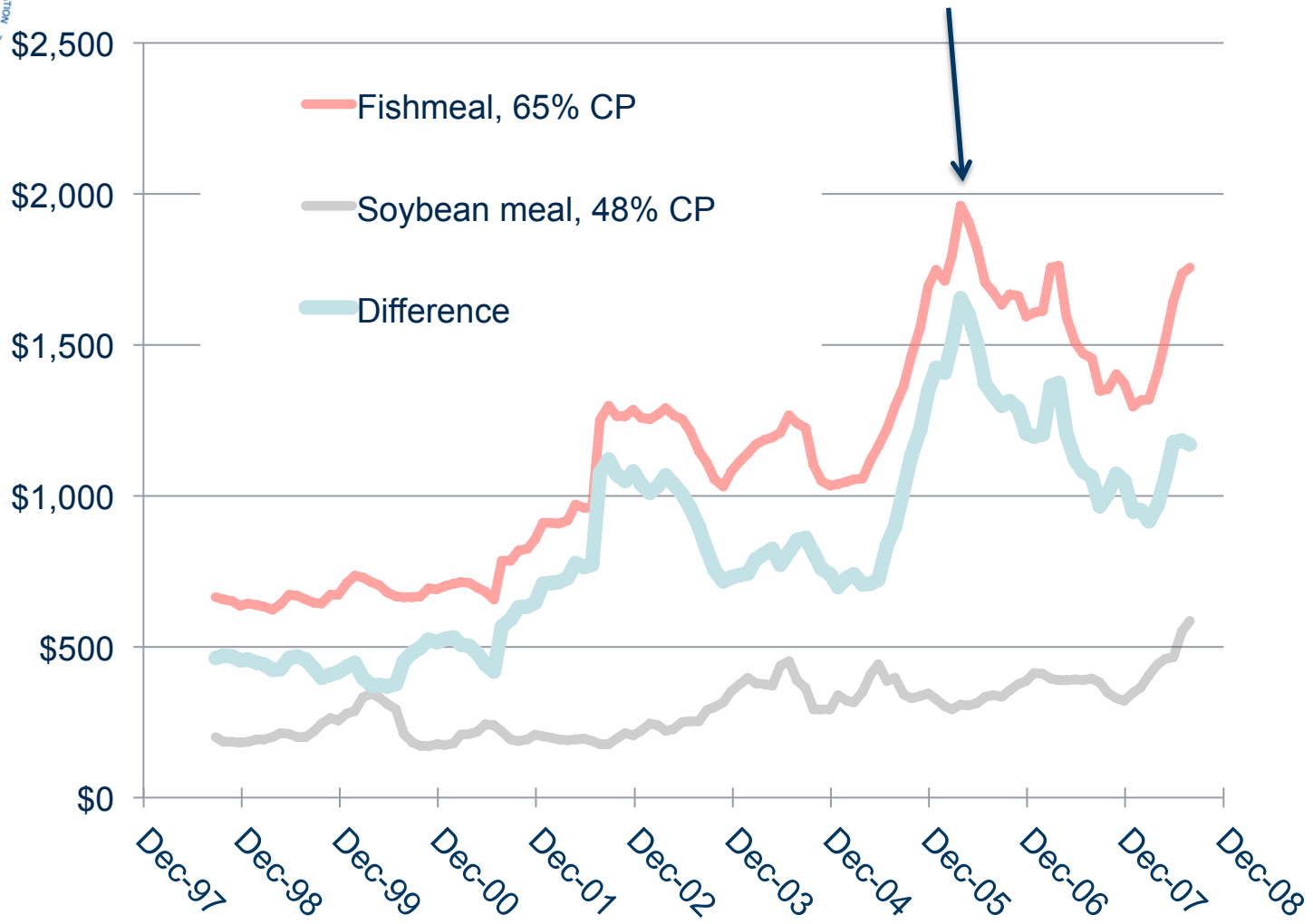
But there is economic scope!



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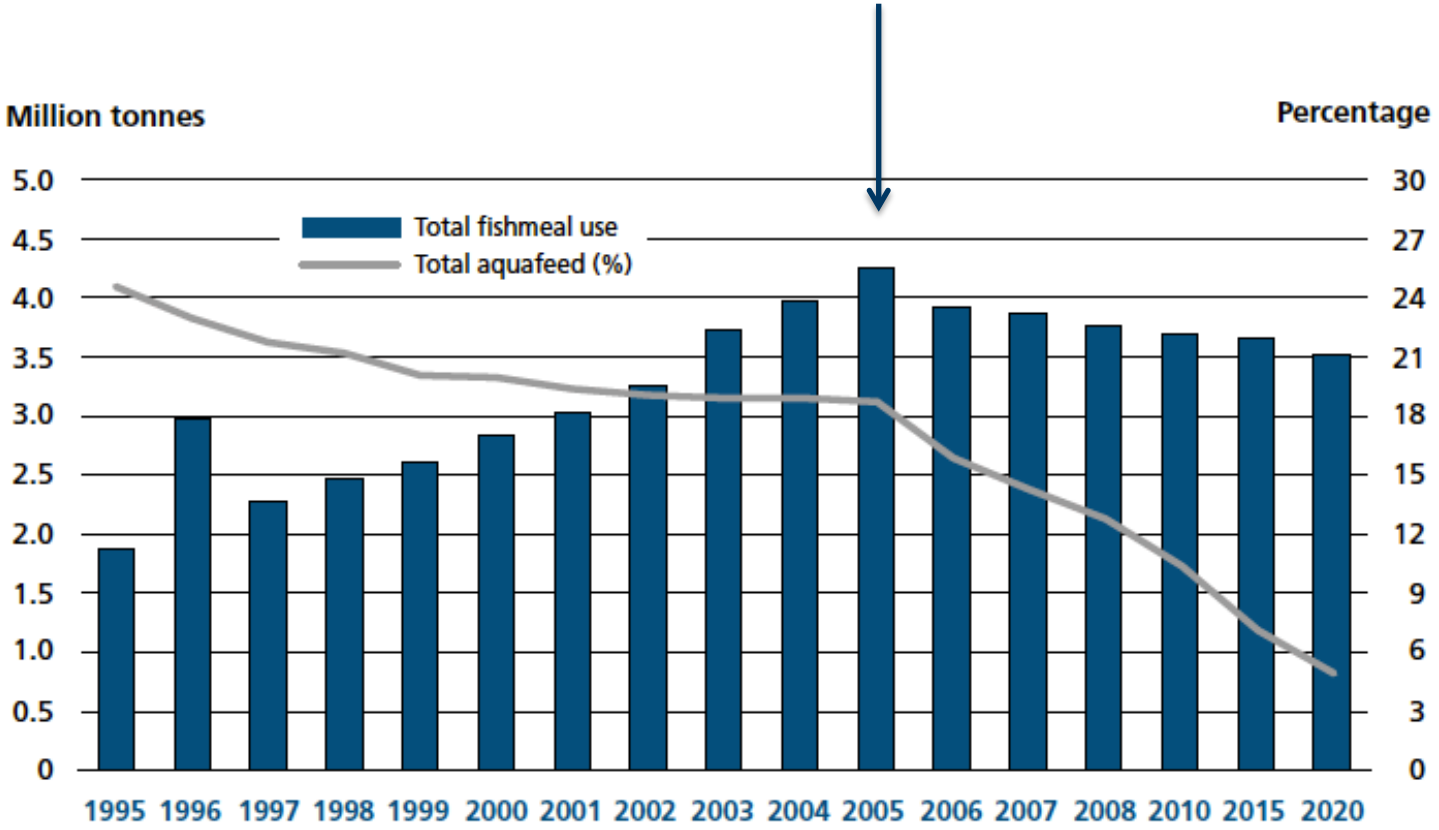
Change is being driven by economics



Source: Adapted from Tacon, A.G.J., Hasan, M.R. and Metian, M. 2011. *Demand and supply of feed ingredients for farmed fish and crustaceans: trends and prospects.* FAO Fisheries and Aquaculture Technical Paper No. 564. Rome, FAO. 87 pp.

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Protein available now

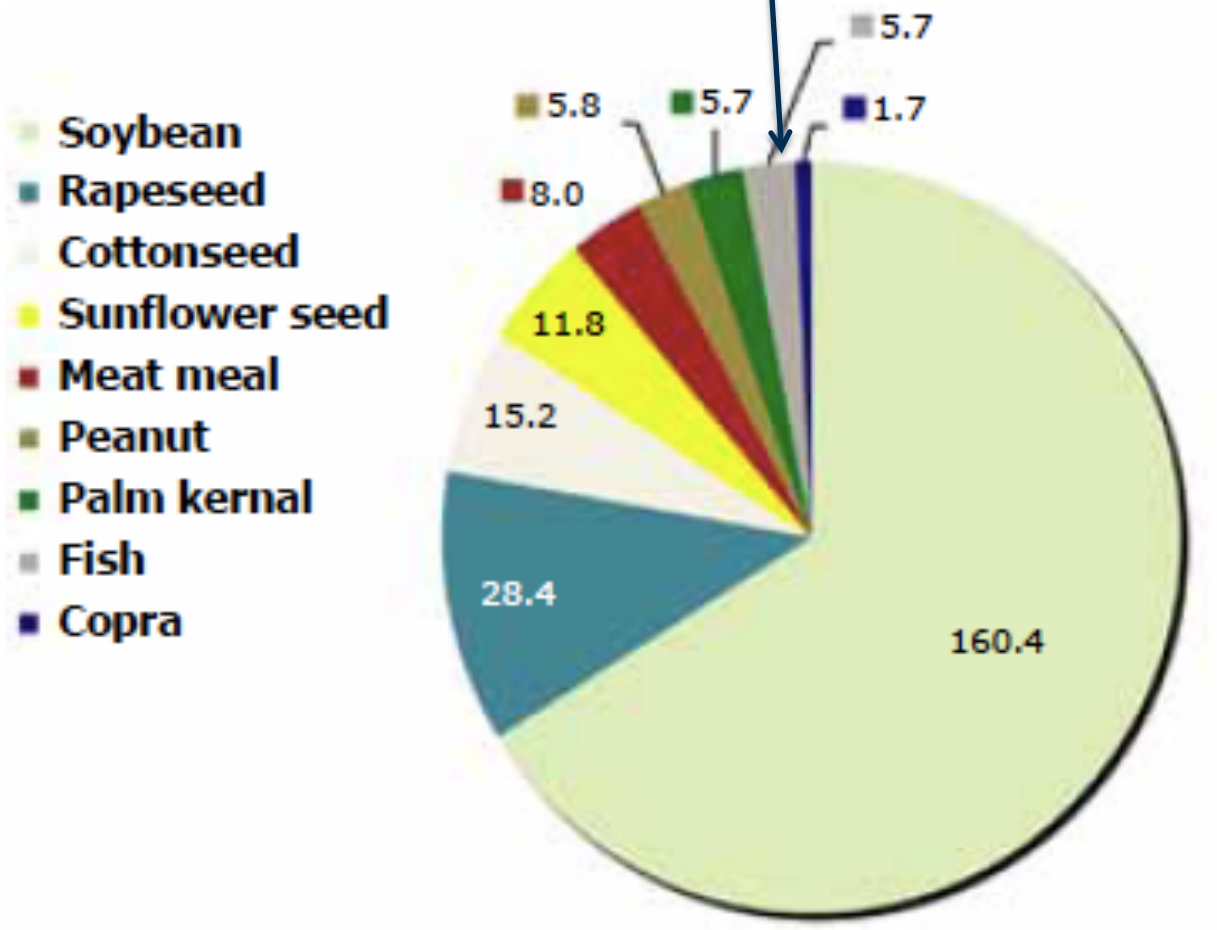

Figure 3
World production of protein meals in 2007 (millions of metric tons)

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Lipid available now

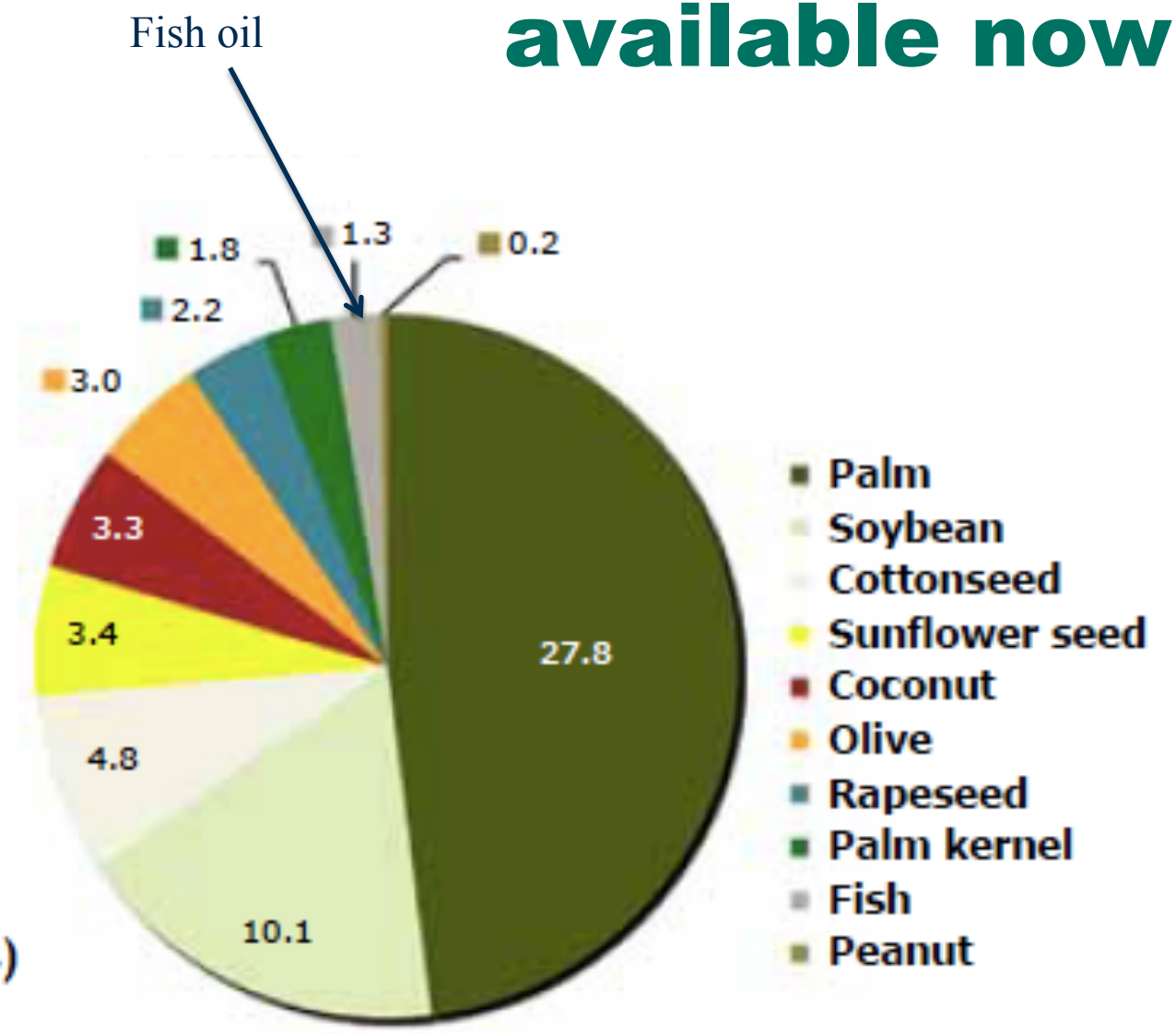

Figure 4
World oil production in 2007 (millions of metric tons)

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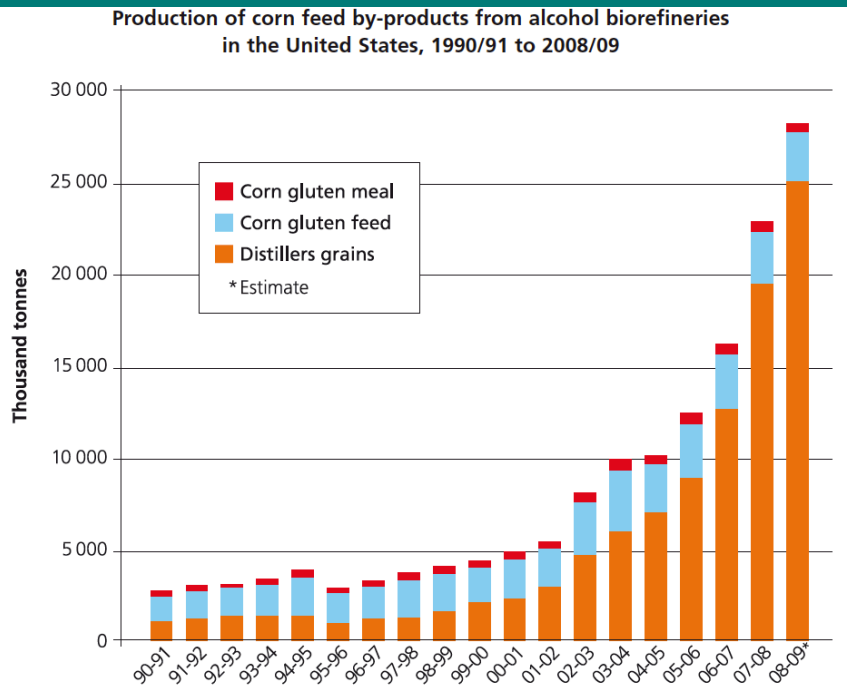
Bioenergy by-products 10-30 years out

- Uses carbohydrates
- DDGS is what is left over from Ethanol
- About 26 MMT in 2008 should be 30-40 MMT in 2015



Source: Renewable Fuels Association: www.ethanolrfa.org/pages/industry–resources–coproducts.

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Micro algae biofuels

10. Algae-based biofuel may present opportunities for feed ingredient production because protein is a byproduct of oil recovery from algae, and marine algae produce the long chain omega-3 fatty acids and certain amino acids important to fish and human health.

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Seaweed – our future 15-50 years out?

For all the reasons John presented in his talk.

Food, Feed, Fiber and Fuel

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Summary

- There is no requirement for fish meal or fish oil for carnivorous fish so we have choices
- Herbivores do not have a big advantage as long as formulated feeds are used.
- Now to 15 years
  - Protein and lipids are available from plants and animal by-products.
- 10 to 30 years
  - Plant/algae based Biofuel production has the potential to produce protein by-products.
- 15 to 50 years
  - Seaweeds have good long term potential